

IF UNIQUE IS WHAT YOU SEEK

Grades 4,5,7

OBJECTIVES	Students will use deductive reasoning, critical thinking, and creative art skills to: <ul style="list-style-type: none"> • Determine how a bird's physical features are adaptations to its environment. • Design a bird to fit an available niche in a native forest • Describe the factors, which fostered adaptive radiation of the Hawaiian honeycreepers.
KEY CONCEPT	Through evolutionary change, descendants of a pioneer bird species developed adaptations to new niches available in the Hawaiian environment.
MATERIALS	large pieces of paper, colored markers
VOCABULARY	niche, adaptation, microclimate, mutation, speciation, adaptive radiation, disharmonic biota, Drepanidinae, plumage.
SUBJECT AREAS	science, art
2005 HAWAII STATE CONTENT STANDARDS	
STANDARD	BENCHMARK
4.3.2	Describe how its' environment affects an organisms behavior (e.g. courting, nesting, feeding patterns.) (Sections 1 – 6)
4.5.2	Describe the roles of various organisms in the same environment. (Sec. 2 – 6) As students make modifications to the common ancestral species to create a bird that would survive in a native Hawaiian Forest, they can make written comments that will help reinforce the idea that species adapt to their environment, not vise-versa.. Plants with long, tubular flowers will only survive if there is a species that can pollinate it, and the same goes for the pollinator.
4.5.3	Describe how different organisms need specific environmental conditions to survive. Throughout this exercise students will learn that each bird species is uniquely adapted to its environment. Due to extreme isolation over time and adaptation, organisms-in this case, Hawaiian honeycreepers- specialize and rely on specific environmental conditions for survival. In an isolated island environment, this specialization a survival advantage, however, in a non-isolated environment, it can become a disadvantage.
5.1.2	Formulate and defend conclusions based on evidence. (Throughout)
7.3.2	Explain the interaction and dependence of organisms on one another. (Section 2 and Grade 7 extension below)
7.3.3	Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem. (Sections 3 – 4)
7.5.4	Analyze how organisms' body structures contribute to their ability to survive and reproduce (Sections 1 – 6)
7.5.6	Explain why variation(s) in a species' gene pool contributes to its survival in a constantly changing environment. (Sections 1 – 6)

OVERVIEW: In this activity, students will design new bird species to adapt to a variety of ecological niches by modifying some of the physical features of a common ancestor.

BACKGROUND: The striking difference in the bills and tongues of the Hawaiian honeycreepers (subfamily Drepanidinae) led nineteenth century scientists to place them in several unrelated families.

The current theory holds that these beautiful and varied birds all evolved from a common ancestor. A new species could arise from a common ancestor when gene changes or mutations had the effect of isolating populations reproductively. For example, if mutations cause changes which result in different breeding seasons, courtship displays, breeding plumage, or songs, such differing birds will no longer be able to breed with one another and thus be “isolated reproductively.” A possible scenario would be the arrival of a pair of birds on an island. If offspring of the birds remained on separate islands, cut off from their ancestral population, and mutations occurred over time causing the population to change physically or in behavior, then these changes might prevent the populations from interbreeding, should they meet in the future. In this way, reproductive isolation creates new species. This process is known as speciation.

When extensive speciation from a common ancestral species occurs, as it did with the Hawaiian honeycreepers, it is referred to as adaptive radiation. The honeycreepers radiated out into a variety of diverse ecological niches or “occupations”, such as seed-eating or nectar-feeding. Four factors set the stage for adaptive radiation:

- 1) Hawai'i's isolation also had the effect of forcing the pioneer populations to remain geographically isolated from their parental populations, thus preventing genetic interchange.
- 2) The extreme isolation of the islands prevented many species of plants and animals from reaching Hawai'i. This gave rise to Hawai'i's disharmonic biota and left a diversity of niches available.
- 3) The lack of seasonal climatic extremes in Hawai'i combined with a range in elevation provided a variety of stable microclimates. This helped to create a diversity of niches.
- 4) As the population of the pioneer species increased, competition arose among the birds for the same foods. As new species arose and expanded their ranges, some to other islands, competition for food developed among species.

The small pioneer honeycreeper population successfully colonized the Hawaiian islands and remained geographically and genetically isolated from its parental population. With the abundance of ecological niches, new species of honeycreepers evolved and made use of a variety of food sources. The honeycreepers exploited available niches by evolving a variety of bills, such as:

- Long, curved bills for reaching nectar at the base of tubular flowers or reaching insects in narrow crevices.
- Heavy parrot-like bills for cracking branches to obtain insect larvae.
- Short thin bills adapted for feeding on nectar or insects.

Procedure:

- 1) Divide students into small groups (2-3 at most). Give each group a copy of the student handout, which illustrates a hypothetical common ancestor and a koa-‘ōhi‘a forest with available niches.
- 2) The hypothetical common ancestor that successfully colonized the islands is believed to be a relative of the Cardueline finches (a group of birds that includes the House Finch). It is generally adapted to eat some insects, seeds, and nectar. Point out the available niches circled on the student handout. Ask students to study the bill of the pioneer species and determine which of the foods it would be able to eat. Note that with its short stubby bill, this bird is unable to reach insects under dense masses of moss, or insects inside branches, or larvae found inside trees. Nectar at the base of tubular flowers is also beyond its reach.
- 3) The population of the pioneer species will grow and the birds will soon be competing for a dwindling food resource. Challenge students to design a new species to occupy an available niche by specializing in eating one or more of the new foods. (The shape and size of bills and feet should be

emphasized.) Groups should note how their modifications have specialized the bird.

4) Each group should then display their unique new species to their classmates and describe how the specific changes they have made provide advantages for inhabiting the new environment.

5) In the follow-up discussion, distinguish between making a conscious decision to change, as students are doing and the mechanism for evolution of new species of birds (gene mutations.) Mutations occur randomly and only some are helpful. Beneficial mutations may give a bird a competitive advantage in adapting to a new environment. Birds that survive to reproduce pass on the new genetic information.

6) Discuss how a new species evolves when birds are isolated reproductively. Introduce the terms speciation and adaptive radiation and compare students' newly designed birds to the diagram of the Hawaiian honeycreepers (which could be used as a transparency). Were any of the students' designs similar to the honeycreepers that evolved and occupied available niches? Note that the honeycreepers are endemic, or unique, to various islands in Hawai'i and that most of them are endangered, and some are extinct. Students should also be aware that in addition to the wet-to-mesic forests illustrated on the student handout, dry forests also provided a variety of niches in the islands.

EXTENSIONS:

Grade 4:

4.5.2:

- 1) After students have created a bird from a common Hawaiian ancestor, have students with birds living in the same (or similar) forest types work together in groups.
- 2) Student groups should discuss the different characteristics their birds have adapted: wing type, food preference (nectar, seeds, insects), beak and foot characteristics, etc.
- 3) Students should discuss the pro's and cons of their bird's specialization (e.g. Pointy/curved beak—great for sipping nectar, but not for cracking seeds, what if their was a severe draught one year?)

Hoike o Haleakalā curriculum has a fun bird activity called win, loose, or adapt located on the web (hard copies are also found in most public school libraries on Maui). This game is appropriate for grades 4 – 7. Visit www.hear.org/hoike. The game is in the rainforest module under Unit 3.

Grade 7:

7.3.2 Explain the interaction and dependence of organisms on one another.

- 1) Have students expand on the material they wrote up about their bird species. For example: If they chose that their bird was a seed and insect eater, the student should detail four insects and seeds that were eaten by their species. Students should choose insects and plants that are native to Hawaii. This may require a bit of library research.
- 2) Following this information, students should research, if necessary, what conditions are necessary for their plant(s) to grow properly, what type of environment would be necessary for their insect to survive, etc. This will help students understand the interconnectedness of the environment.
- 3) Students should share their results either with the teacher on paper or to the class as a presentation.

Other Suggestions:

Challenge students to hypothesize the factors which, fostered the remarkable adaptive radiation of the Hawaiian honeycreepers. You may need to assist them by relating some of the four factors noted in the background information above. Ask students to describe how these factors set the stage for adaptive radiation.

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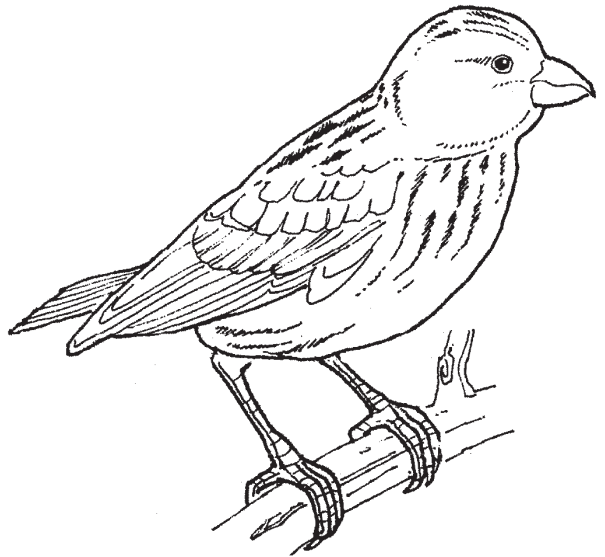
Activity Handout

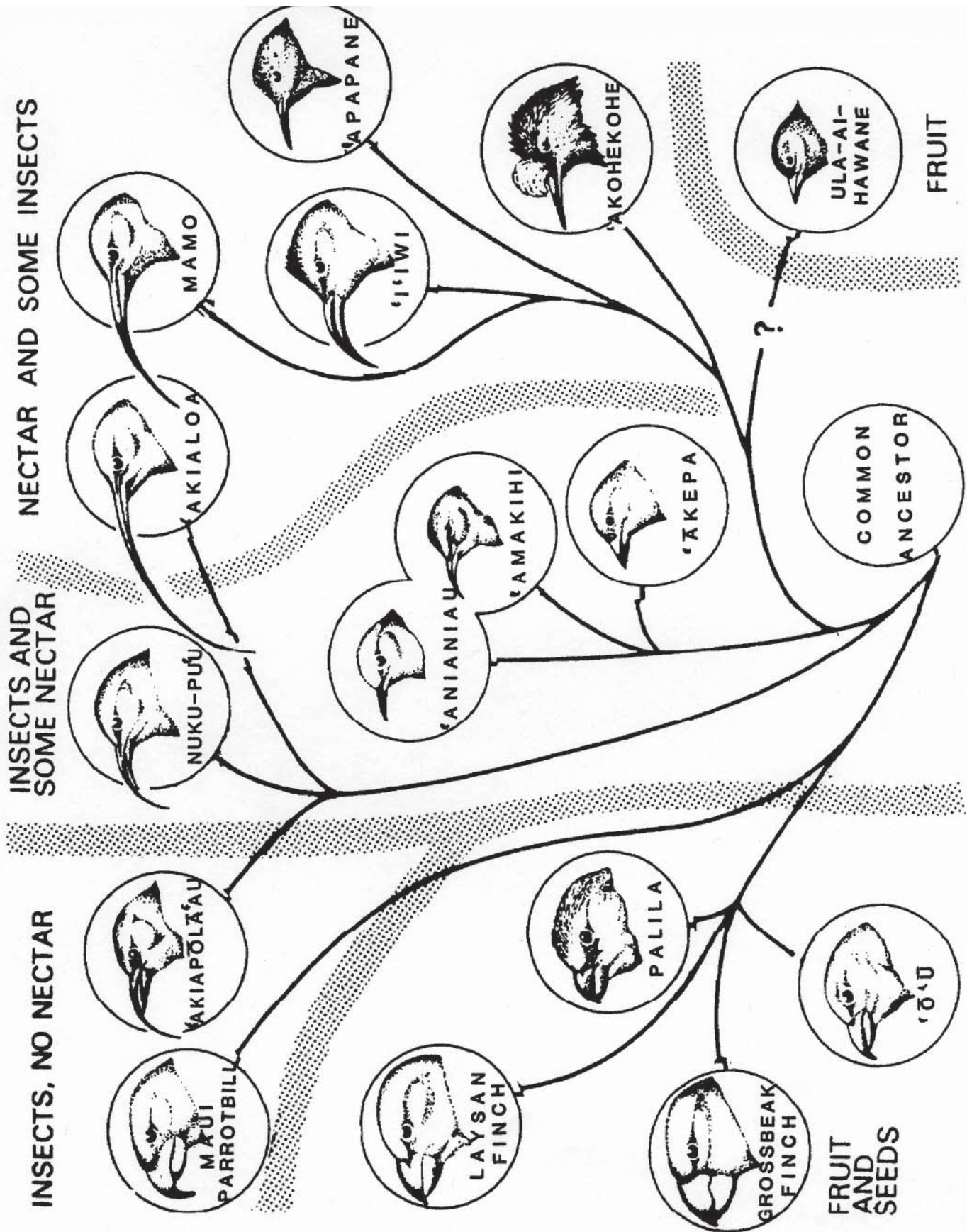
A pair of birds like the one pictured here just arrived on an island that is 2500 miles from the nearest continent. This pioneer species eats insects and nectar. There are no mammals on the island, but there are insects and tiny tree snails.

When the population of this species grows quite large, the birds will compete for foods. How will the birds survive without running out of food? Many more niches in the koa-'ōhi'a forest are available. But the pioneer species cannot efficiently reach or handle all of these foods.

Design a new bird, similar to the common ancestor, to occupy one or more of the following niches: (see numbered circles)

- 1) Eating pilo berries
- 2) Eating thick-coated koa seeds
- 3) Probing under thick masses of moss for insects
- 4) Crunching open branches for insects
- 5) Pecking through thick bark for insect larvae
- 6) Eating tree snails
- 7) Taking nectar from the base of long, tubular flowers





Source: Biogeography, C. Barry Cox & Peter D. Moore, 4th Edition, Copyright 1985, Blackwell Scientific Publications